

A NEW BLOOD-FLUKE, *CARDICOLA FORSTERI*, (DIGENEA: SANGUINICOLIDAE) OF SOUTHERN BLUE-FIN TUNA (*THUNNUS MACCOYII*) IN AQUACULTURE

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Summary

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Cardicola forsteri sp. nov. (Digenea: Sanguinicolidae) is described from the heart of captive southern blue-fin tuna, *Thunnus maccoyii* (Scombridae), from South Australia. The new species is distinguished from other species of *Cardicola* by its very extensive testis, the length of its oesophagus, the length of its gut caeca and the form of its ovary. *Cardicola smithi* appears to be associated with heart and gill lesions¹.

Introduction

The southern blue-fin tuna (*Thunnus maccoyii*) has been used for aquaculture in southern Australia since 1992. The industry is based on the capture of juvenile fish and their subsequent fattening over a period of 6-9 months. The tuna have been subject to remarkably few diseases so far. Here we report a new parasite, a sanguinicolid blood-fluke; the associated pathogenesis will be described elsewhere.

Materials and Methods

Trematodes were collected from the hearts of freshly-killed fish hosts and fixed by pipetting them into near boiling phosphate buffered saline followed by immediate preservation in 10% neutral buffered formalin. Whole-mounts were stained with Mayer's haematoxylin, cleared with methyl salicylate and mounted in Canada balsam. Specimens for sectioning were embedded in paraffin wax, stained with haematoxylin and eosin and mounted in DEPEX. The following abbreviations are used: AHC, The Australian Helminthological Collection at the South Australian Museum, Adelaide; QM, Queensland Museum, Brisbane.

Systematics

Family Sanguinicolidae von Graff, 1907
Cardicola Short, 1953

Cardicola forsteri sp. nov.
(FIG. 1)

Type host: Scombridae - *Thunnus maccoyii* (Castlenau, 1872).

Type locality: Off Rabbit Island, South Australia, 34° 36' S, 135° 59' E

Other localities: Louth Island, South Australia, 34° 35' S, 135° 57' E.

Site: heart.

Material examined: 15 adults including 3 sets of histological sections from Rabbit Is., 11 from Louth Is.

Deposition of specimens: Holotype and 9 paratypes (including 3 sets of sections) AHC 28331 - 28340; 5 paratypes QM G 218017-21.

Description

(Measurements in µm of 10 gravid adults (means in parenthesis))

Body lanceolate, highly compressed dorso-ventrally, almost flat ventrally and convex dorsally, 2512-3688 (3228) x 608-928 (759). Tegumental spines restricted to distinct ventro-lateral rows (Fig. 1 a, c, d). Nerve commissure dorsal to oesophagus and just posterior to anterior end of body; main nerve bundles highly prominent in anterior half of body and discernible almost to posterior end of body.

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³ Colquhoun, S. E. (1999) Histopathological changes in, and immune response of, southern bluefin tuna (*Thunnus maccoyii*) infected with *Cardicola* sp. (Digenea: Sanguinicolidae). Honours thesis, University of Tasmania (unpubl.).

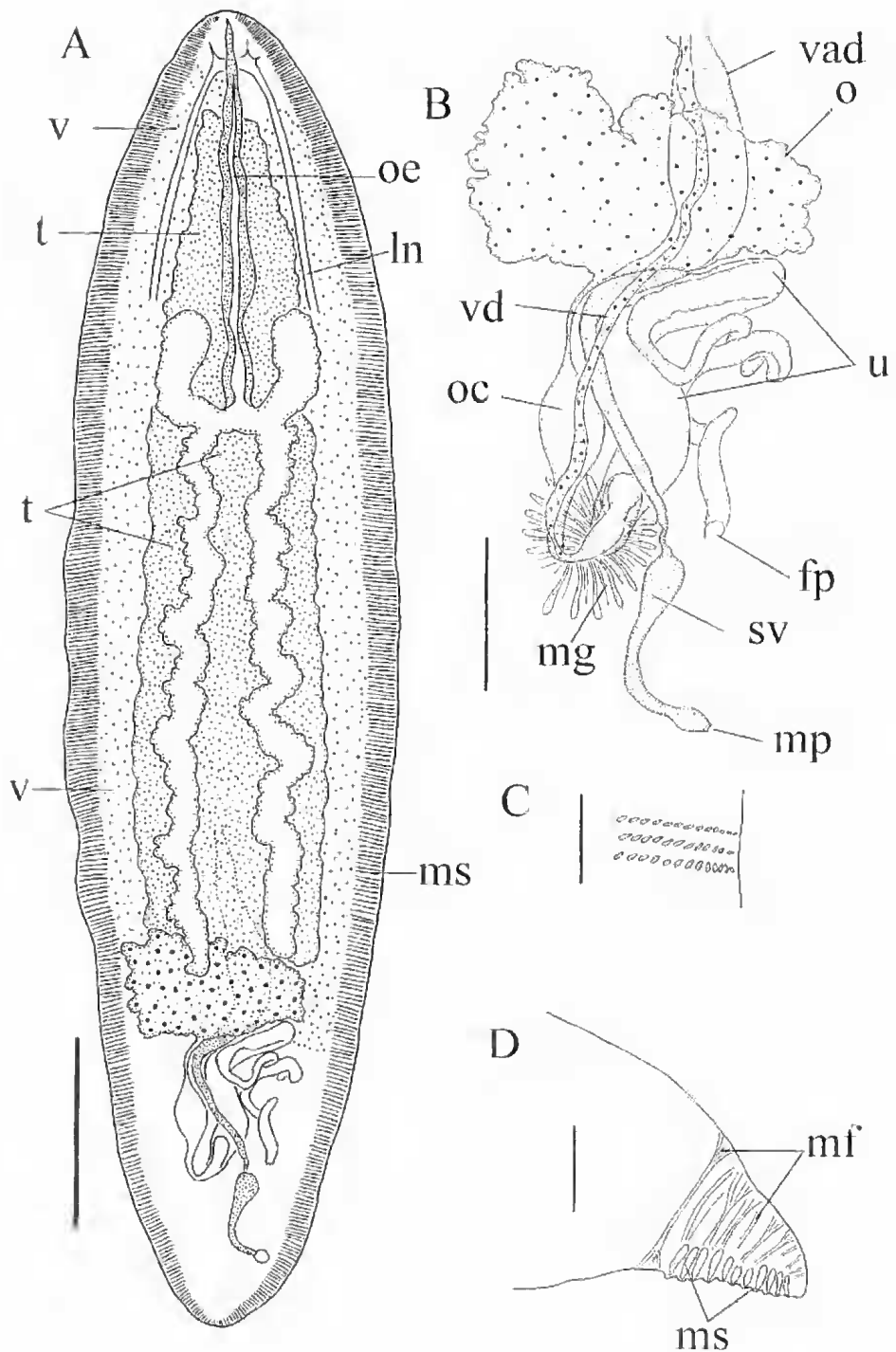


Fig. 1. *Cardicola forsteri* sp. nov. A. Adult, ventral view. B. Terminal genitalia, ventral view. C. Marginal spines, ventral view. D. Marginal spines and lateral muscles in transverse section. Scale bars = 500 μ m A; 200 μ m B; 50 μ m C, D. Abbreviations: fp = female pore, ln = lateral nerve, mf = muscle fibres, mg = Mehlis' gland, mp = male pore, ms = marginal spines, o = ovary, oe = oviductal chamber, oe = oesophagus, sv = seminal vesicle, t = testes, u = uterus, v = vitellarium, vad = vas deferens, vd = vitelline duct.

Mouth inconspicuous, opening ventro-subterminally. Oesophagus highly muscular, straight, 816–1136 (1014) long, 29.1–33.4 (31.5)% body length. Caeca H-shaped, sinuous; extending anteriorly to 672–928 (833) from anterior end of body; posterior caeca usually of distinctly uneven length, extending to 560–912 (777) from posterior end of body. Testis usually indistinct and difficult to discern, intra- and extra-caecal, extending from ovary posteriorly to just behind nervous commissure anteriorly; penetrated by dorso-ventrally orientated muscle fibres throughout. Vas deferens broad, prominent, originating midventrally to testis, running sinuously posteriorly, dorsal to ovary and ventral to uterus before entering seminal vesicle. Cirrus-sac absent. Seminal vesicle elongate, evenly curved, 116–238 (174) x 26–64 (45). Male genital pore sinistro-dorsal, close to lateral margin of body. Ovary irregularly lobed, penetrated by dorso-ventrally orientated muscle fibres throughout, 138–321 (237) x 263–462 (376). Oviduct originating posteriorly and passing posteriorly immediately to expand into oviductal chamber of variable size containing either oocytes (and perhaps zygotes) or sperm; if filled with sperm, chamber may become relatively enormous – up to 257 x 116. Duct emerging from oviductal chamber joined by vitelline duct then turning antero-medially and forming polype surrounded by prominent Melnik's gland cells. Vitelline follicles are diffuse and throughout body from level of anterior margin of ovary (sometimes lateral to ovary as well), dorsal and ventral to testis, and as far anteriorly as nervous commissure. Vitelline duct passes ventral to testis and ovary. Uterus filled with eggs, winding sinuously to ovary and then posteriorly to female genital pore, directly anterior to and well separated from male pore. Eggs very thin-walled and compressed against each other, 19–27 (23) x 11–16 (14). Excretory system not observed.

Etymology

The species is named for Mr Ron Forster, South Australian tuna farmer, in recognition of his contribution to the development of the enlightened management of captive tuna.

Discussion

The new species shows close affinity with the genus *Cardicola* Short, 1953 and is here identified as a new species in that genus. *Cardicola* is distinguishable from other genera of marine Sanguinicolidae by the combination of an H-shaped gut, a single largely inter-caecal testis, lack of a cirrus-sac, post-ovarian uterus and separate submarginal genital pores (Herbert *et al.* 1994). The present species agrees with all these characters except

that the testis is both inter- and extra-caecal, although one other species of *Cardicola*, *C. mugilis* Yamaguti, 1970, also has a partly extra-caecal testis. Only species of *Deontacylix* Linton, 1910 and *Pearsonellum* Overstreet & Køie, 1989 also have extra-caecal testes. Species of *Deontacylix* Linton, 1910 have a testis comprising "longitudinally elongated wings" (Yamaguti 1970) which extend lateral to the caeca in a form entirely different from that seen in the present species. The distribution of the vitellarium in the sole species of *Pearsonellum*, *P. corventum* Overstreet & Køie, 1989, is comparable to that of the present species, being both anterior to the caecal bifurcation and lateral to the posterior caeca, but that genus is distinct from the present species in possessing a cirrus-sac (Overstreet & Køie 1989).

Cardicola was erected (Short 1953) for *C. larvae* Short, 1953 from two species of *Cynascion* (Sciaenidae). Subsequently, nine further species have been described or combined with this genus (Smith, 1997a,b) namely *C. ahi* Yamaguti, 1970, *C. cardicola* (Mantel, 1947) Short, 1953, *C. chaetodontis* Yamaguti, 1970, *C. coriodactis* Mantel, 1954, *C. grandis* Lebedev & Mamaev, 1968 (not mentioned by Smith, 1997a,b), *C. mugilis* Yamaguti, 1970, *C. whittemi* Mantel, 1954, *C. congruentia* Lebedev & Mamaev, 1968 and *C. brasiliensis* Knoff & Amato, 1992. Two of the species, *C. ahi* and *C. congruentia* have been reported from tuna (family Scombridae, subfamily Thunninae).

The present species is immediately distinguished from all these species by the more extensive distribution of the testis which is both anterior to the caecal bifurcation and well lateral to the posteriorly directed caeca. In this study, however, we found the distribution of the testis exceedingly difficult to interpret and, although we find it convincing as a species-level character, we conclude that it is not an ideal character for recognition of species in this genus. Fortunately, several other characters also serve to distinguish this species. The length of the oesophagus, occupying 29–33% of the body length serves to distinguish it from *C. ahi* in which it is very short (approx. 18%) and species in which it is very long *C. cardicola* (41%) and *C. larvae* (50%). The relatively very short posterior caeca of *C. congruentia* and the short divergent anteriorly directed caeca of *C. brasiliensis*, *C. chaetodontis*, *C. mugilis* and *C. whittemi* are distinct from the relatively long posterior caeca and the parallel anteriorly directed caeca of the present species. The present species generally resembles *C. coriodactis* but has a relatively larger and irregularly lobed rather than smooth ovary and has relatively shorter anteriorly directed gut caeca. Finally, *C. grandis* from a mullet (*Makaira* sp.) is a much larger worm (4.7–7.0 mm long compared with 2.5–3.7 mm for the present species). Its general

organisation is similar to that of the present species except that the testis is described as a single mass immediately behind the caecal bifurcation.

Overstreet & Køie (1989), Herbert *et al.* (1994) and other authors have frequently referred to the presence of numerous dorso-ventrally orientated "ducts" or "structures" in sanguinicolids. These often pass through the gonads. Such structures are abundant in *Cardicola forsteri* and are here interpreted, as suggested in Herbert *et al.* (1994), as

muscle fibres. This interpretation appears reasonable in terms of the appearance of these refringent structures and in terms of function in trematodes where the requirement for flattening against the walls of blood vessels is clearly of great importance.

Acknowledgments

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